Space Weather Technical Forecast

Issued on Thursday, 27 October 2022 at 13:14 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1/Minor geomagnetic storms throughout. Chance of Minor (R1) Radio Blackouts throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity over the past 24 hours has been Low, with one C-class flare, peaking at C6.7 at 26/1243 UTC, originating from AR3133 Csi/Beta in the northeast quadrant. This has been the most active sunspot region on the disc with some growth due to a proliferation of small intermediate spots. The most developmental region has been AR3130 Dac/Beta in the southwest, increasing in penumbral extent with ongoing emergent flux south of its largest trailer spot. The largest region, however, is the simpler AR3131 Cho/Beta also in the northwest, although this has a simpler magnetic structure. There are two other smaller regions, AR3126 Cai/Beta soon to rotate off the visible disc and AR3132 Bxo/Beta which faded and then reemerged as a small region in the last 24 hours. A CME was observed on the Earth-Sun line, and this has been associated with a filament eruption from the far south of the Sun A full analysis has yet to be completed, however any material is expected to pass to the south and well below the Earth's orbit. No other Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1 has been indicative of background conditions with speeds generally below 400km/s. The density was above average at times between 26/2000 UTC and 27/0400 UTC, peaking 18ppcc, but was otherwise at or below average. Total IMF strength was weak at 7nT, with the north-south component, Bz, varying between 5nT and -7nT, but mostly in a negative (southward) direction. Phi angle was initially negative (towards the Sun), but switched to be mainly positive (away from Sun) after 26/2100 UTC, albeit with further brief rotations back to negative Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 has remained at background levels. High energy electron flux (greater than 2MeV) at GOES-16 was mainly at background. The associated 24-hour integrated fluence was well below the Active (1e8 integrated pfu) threshold. 3.75e6 integrated pfu observed at 27/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be mainly Low, but with a daily chance of isolated M-flares due to the developing sunspot regions on the disc. These most likely from AR3130 or AR3133.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Coronal hole fast wind enhancements are expected through the period. The first of these day 1 or early day 2 (27th or 28th), from CH36/+. A more notable enhancement is then expected from CH37/+, most likely day 3 (29th), with fast winds persisting day 4 (30th). Quiet to Unsettled geomagnetic activity will become enhanced at times through the period, giving spells of Active with a chance of G1/Minor Storms, most likely day 3 (29th) but possible throughout the period.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV)

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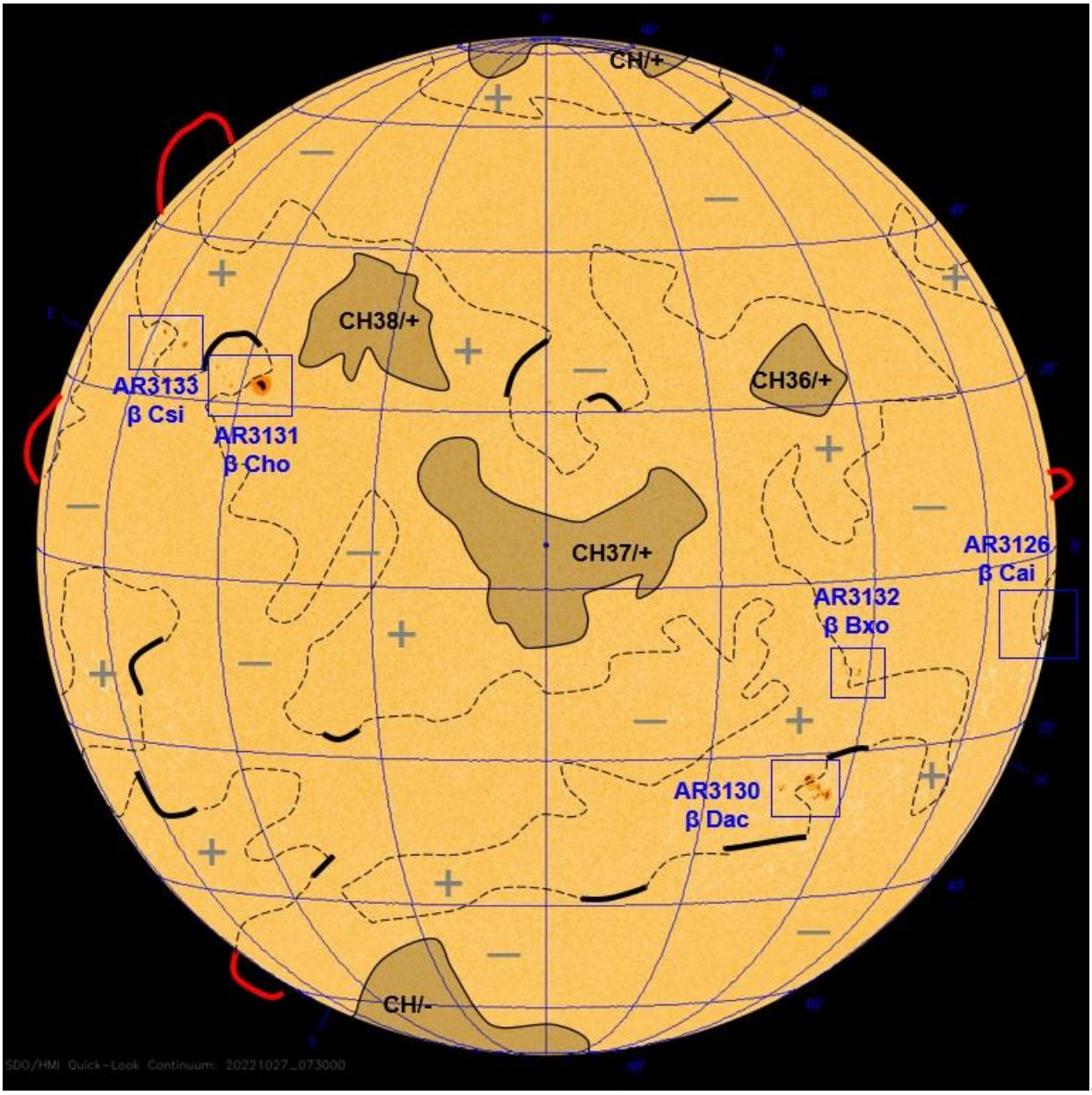
observed by GOES-16 is expected to be at background levels. High energy electron flux (greater than 2MeV) observed by GOES-16 is expected to be at background for much of the period, with any fast wind arrivals likely limiting the observed flux levels, due to the increased solar wind pressure. The associated 24 hour electron fluence is expected to remain below the Active threshold.

Figure 1. Solar Analysis Valid 27/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no Earth-directed CMEs.

There are a series of coronal holes on the Earth-facing disc. These are recurrent features, with solar wind persistence from the last 27 day rotation likely providing a good guide to likely conditions. CH36/+ is the leading coronal hole, with the associated fast wind likely arriving day later day 1 (27th) or early day 2 (28th), although this coronal hole is reduced compared to the previous rotation. A fairly rapid transition into the fast wind of CH37/+ follows, most likely on day 3 (29th), before persisting day 4 (30th). The fast wind from the third coronal hole CH38/+ is then expected to arrive on day 5 (31st), just beyond this forecast period.

This sequence of fast wind arrivals is likely to result in initially Quiet to Unsettled geomagnetic activity becoming enhanced at times through the period giving spells of Active, with on ongoing chance of G1/Minor Storms. These most likely with the arrival of CH38/+, with the greatest risk day 3, (29th) but possible throughout the period.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	30	40	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2a: Solar wind persistence Model

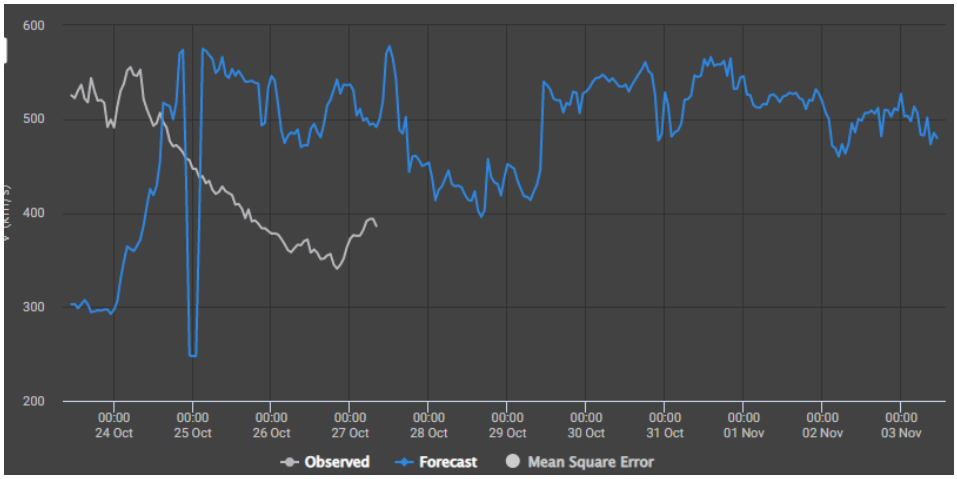

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Figure 2b: SDO aia-211 of current and previous rotation, showing very similar coronal hole structure

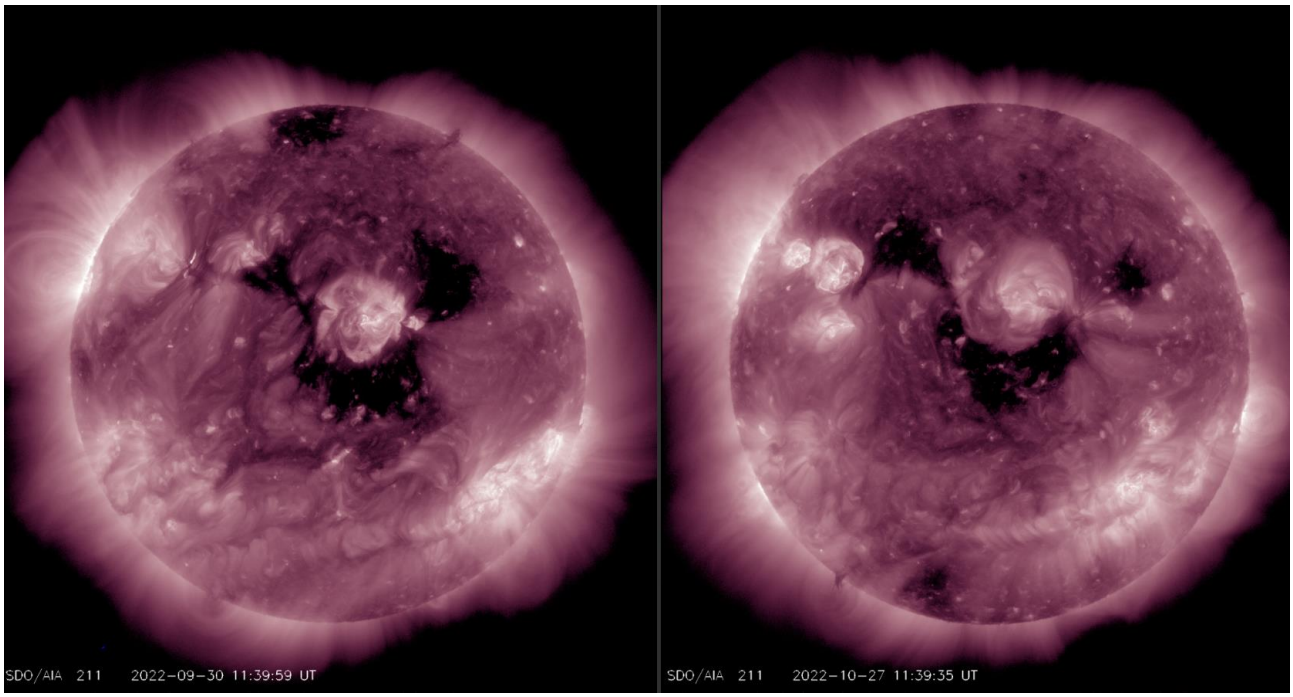
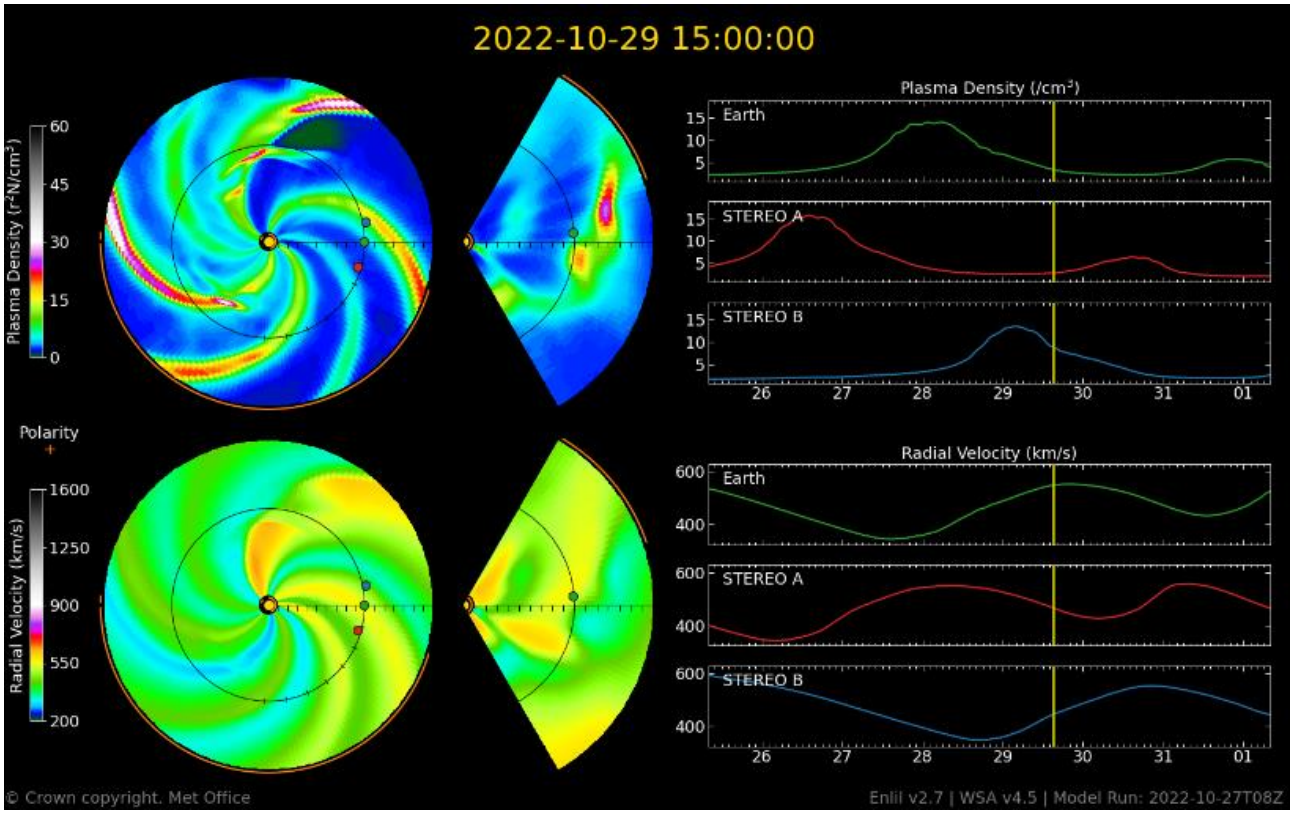


Figure 2c: Enlil forecast for solar winds at Earth.



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Radio Blackouts - X-Ray Flares:

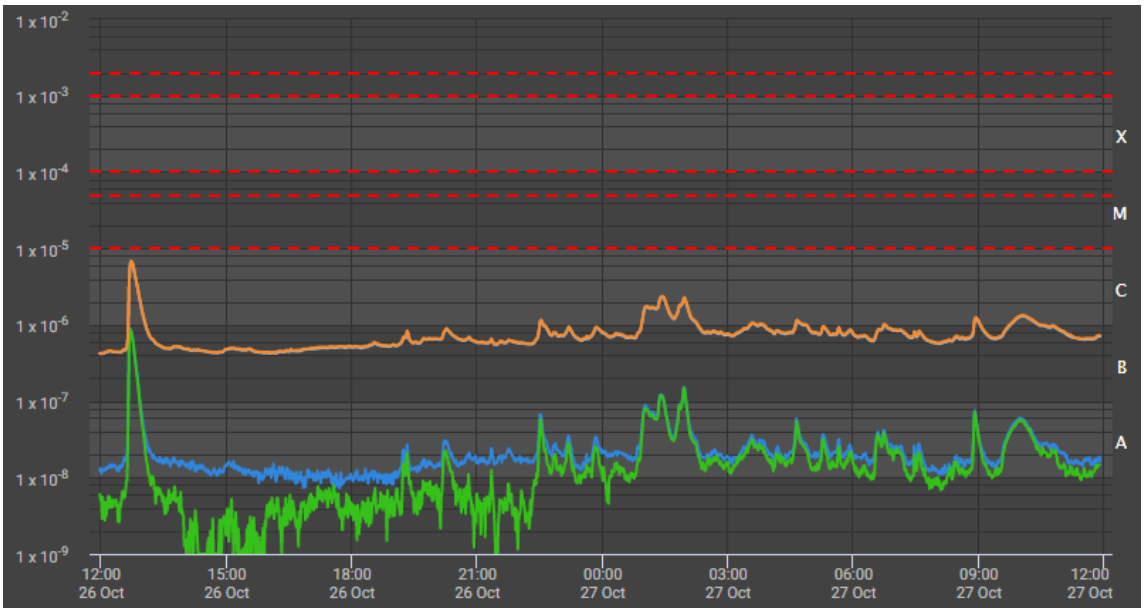
Solar Activity is currently Low, but on an increasing trend with five sunspots on the Earth-facing disc. Low level is expected to continue, but with a daily chance of rising to Moderate with isolated M-flares possible.

The most likely source of flaring is the small, but compact and developing sunspot AR3130 Dac/Beta. This has a northeast to southwest aligned field, with some potential to complexity further. AR3133 Dai/Beta in the northeast is also small but developing region, with a north-south aligned magnetic field, and was the source of the largest flare (C6.7) in the last 24 hours. Nearby AR3131 Cho/Beta is of a simpler and more open magnetic structure, despite being the largest sunspot on the disc. The other regions include AR3126 Cai/Beta, which is soon to rotate off the visible disc, over the western solar horizon, and AR3132 Bxo/Beta a much smaller but re-emergent sunspot that has both faded, and returned in the last 24 hours.

A further source of potential activity is a large region of magnetic looping notable on SDO imagery on the northeast limb. This is supported by a strong signal in helioseismic products, suggesting the potential for a further notable region or regions to rotate onto the northeast disc through the period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	25	25	25	25
Very Active	R3 to R5 X Class	No	2	2	2	2

Figure 3: GOES-16 X-ray flux



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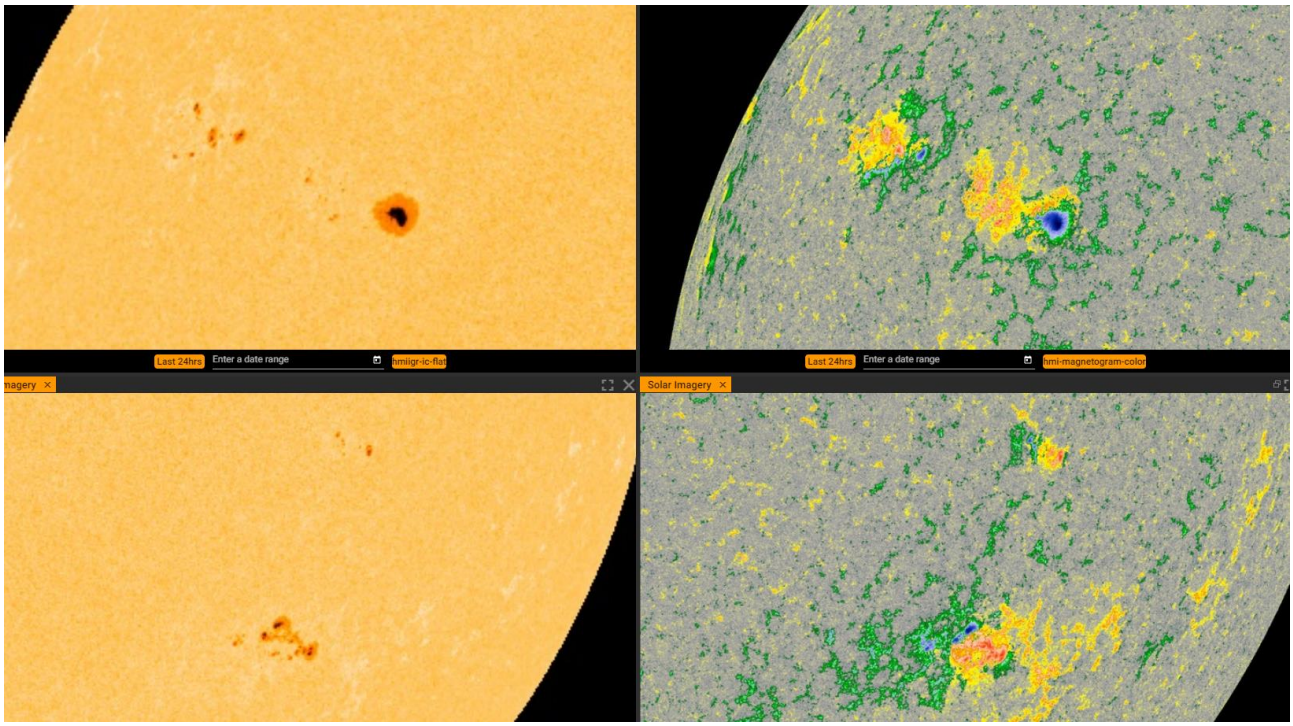
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES16 is currently at background. The current sunspot regions on the solar disc are unlikely to produce observable radiation storms at Earth, although a very slightly above background risk has been introduced due to AR3126 on the southwest limb, and AR3130 developing in the southwest disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: SDO hmi- Magnetogram and Intensitygram AR3133 and AR3131 (top) and AR3130 and AR3132 (south)



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High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux as measured by GOES-16 has been largely at background. The next notable enhancement is likely to be from the arrival of the fast wind of coronal holes 36, 37 and also 38 beyond this period. These appear similar to the previous rotation and a similar progression appears likely on this rotation. This will likely enhance electron flux in the Van Allen belts, but will also result in increased solar wind pressure for a prolonged period, limiting observable values at GEO. This gives a low chance of reaching high flux levels on day 4 (30th).

The associated electron fluence is expected to remain below the Active threshold through the period, with flux unlikely to increase sufficiently to reach Active levels by the end of day 4 (30th), albeit with decreasing confidence. This is supported by both REFM and recurrence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	10	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: GOES-16 >2MeV Electron Flux (top) and Fluence (bottom) with REFM and Recurrence.

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